

Parental care



Parental care

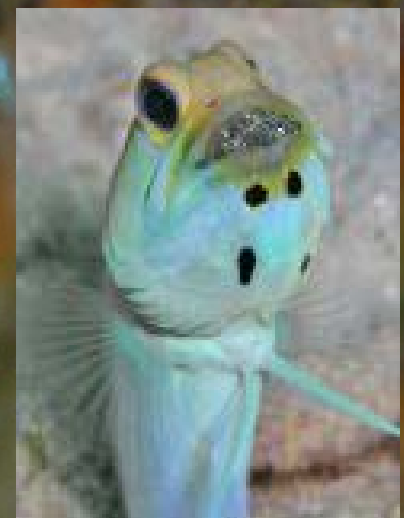
1. Costs and benefits of parental care
2. Sexual conflicts in parental care
3. Parent-offspring recognition
4. Parent-offspring conflicts

1.To care or not to care?

Costs and benefits of parental care

Produce more offspring with
less parental care, or

Produce less offspring with
more parental care?





More or less parental care ?



1. To care or not to care?

Care enhances offspring survival?
-- protection from predation

Limitation of food or other resources:
abundant food → less cost for care

Lifetime reproductive investment
parents tend to have more
offspring in their lifetime.

2. Why is parental care more often
maternal than paternal?

Female cost vs. benefit:

Females have already invested so much in producing eggs + physiological constraints. Females are sure of their genes will pass on, if the eggs are fertilized internally. Depending on offspring survival

Male cost vs. benefit:

Males tend to mate as many mates as possible, invest more energy on attracting females. Males are not sure if their genes will pass on. Depending on offspring survival

Male fishes are unusual that they often provide uni-parental care:

Why?



Stickleback

Male fishes are unusual that they often provide uni-parental care:

1. external fertilization
2. defend territory
3. ensure paternity



Randall's Jawfish



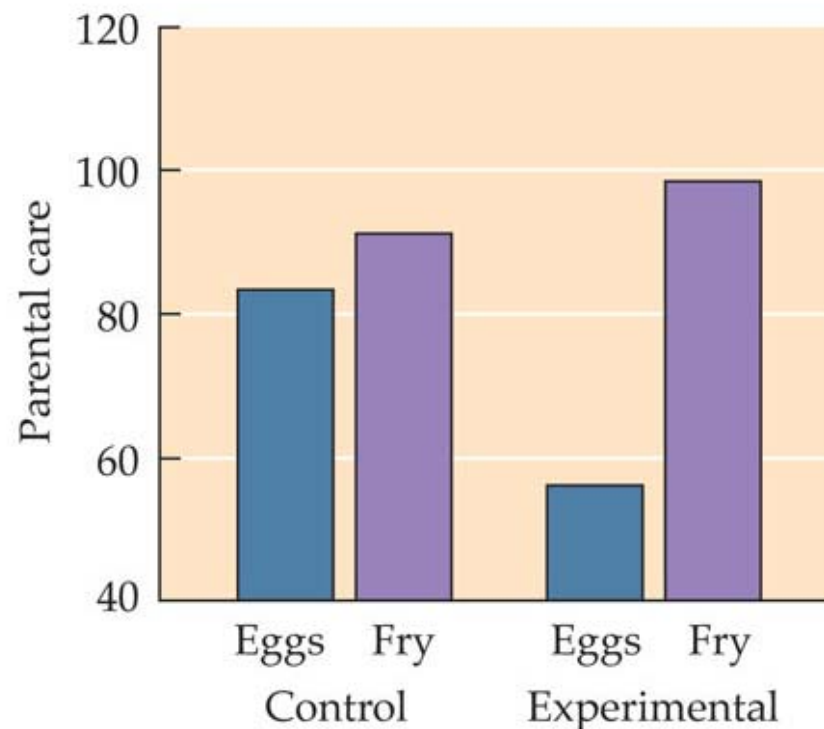
Stickleback

Paternal behavior might evolve when males can ensure paternity

Hypothesis: Males are more likely to take care of young if they “know” they’re the dad



Bluegill



Experiments:

Temporarily remove the father fish during egg stage or fry stage....

Parental care

1. Costs and benefits of parental care
2. Sexual conflicts in parental care
3. **Parent-offspring recognition**
4. Parent-offspring conflicts

3. Parent-offspring recognition



Many colonial species recognize offspring

Parent-offspring recognition

Parents should avoid caring young that are not their own offspring,

But not all species recognize their own progeny



Offspring recognition: function to prevent misdirected parental care.

Prediction: Parents should be especially good at identifying their own young in colonial species (living in a social group) but not as well in solitary species.

Mexican free-tailed bats

Pregnant females form colonies in the millions...

~4000 pups per square meters

Can mother bats nurse discriminately?



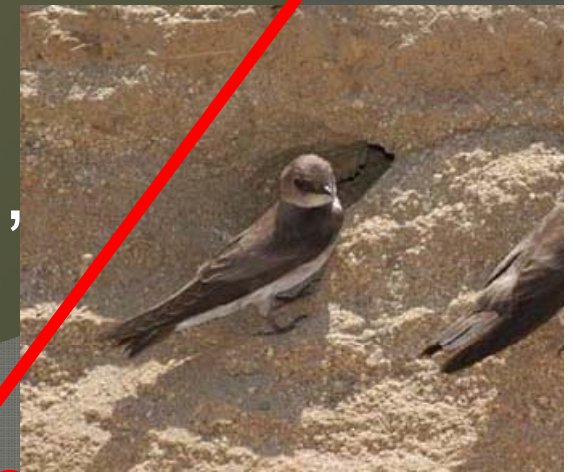
Yes, recognize
the odor and call
of its young

Bank swallows and rough-winged swallows are closely related

Bank swallows: **colonial** species, fledglings have distinctive begging calls



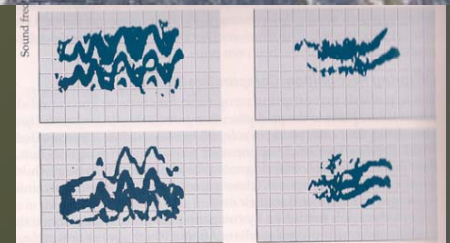
Rough-winged swallows: **solitary** species: fledglings have, less distinctive begging calls



What species can recognize their young?

Cliff swallows and barn swallows are closely related

Cliff swallows: **colonial** species;
nestlings have distinctive,
highly variable begging calls
Parents recognize their young.



Barn swallows: **solitary** species
fledglings have less distinctive calls
Parents do not recognize the young



Parent-offspring recognition

Parents should avoid caring young that are not their own offspring.

Species can not identify their own, individual offspring:

1. Many solitary/ territorial species and
2. Species provide less/ no care

Species provide less/ no care:

Precocial species

(feather grown, feed,
eyes open, standing)

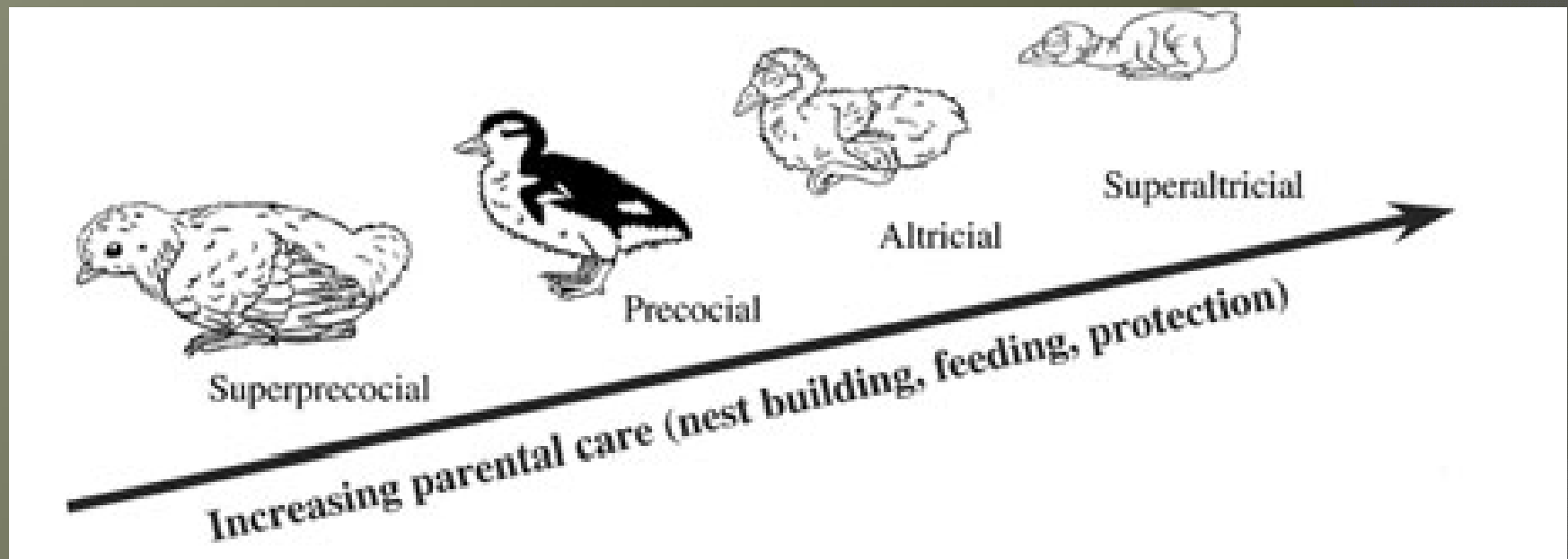
VS.

Altricial species

(naked, eyes close,
depend on parents)

What species is more likely to recognize their offspring individually?

2. Precocial species provide less/ no care, parents less likely to recognize offspring



When parents do not recognize their offspring:
Some take advantage of it by dumping the eggs
to other nests and let other birds do the parenting



Intra-specific
brood parasitism

Wood ducks
(egg-dumping)
parasitize neighbors
of the **same** species

When parents (solitary, territorial specie)
do not recognize their offspring:
Some take advantage of it by dumping the eggs
to other nests and let other birds do the parenting



Inter-specific
brood parasitism

European cuckoos

parasitize the nest
of **other** species

Inter-specific brood parasitism

Brown-headed cowbirds (parasitize 216 host species)

Host parents fail to recognize parasitic cowbird young



Host-parents sit on whatever eggs in their nest
“fail” to recognize parasitic cowbird egg.....



Parasitic cowbirds lay eggs in other species' nest

Parasitize > 200 species



Parasitic cowbird's strategies:

1. Hatch earlier than host young
2. Grow faster than host young
3. Parent cowbirds revenge if host parents don't sit on it.



Interspecific brood parasitism

Brown-headed cowbirds (parasitize 216 host species)



Parental care

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Parent-offspring conflicts

Parent's best interest:

care as **many healthy** offspring
as possible: lifetime investment.

Strategies: a few well-fed offspring
or many less healthy offspring?
- depending on resource limit

Parent – offspring conflicts

Offspring's best interest:

maximize each individual's needs,
at the cost of parents or/ and
other siblings' survival.

Parent-offspring conflicts between **nestlings** and parents



Food begging call as signal for hunger;
but also a manipulative tool

Parent-offspring conflicts between **infants** and parents



Crying signals infant's need,
But also can be used by infants, as a manipulative tool,
to maximize infant's benefits

Parent-offspring conflicts

Infanticide



Lions and monkeys:
infanticide by males



Understand species-specific natural history is essential to
understand the evolution of animal behavior

Parent-offspring conflicts

Infanticide



killed by females

Polyandrous jacanas

Why infanticide?

1. Sexual selection hypothesis,

infanticidal males will gain a reproductive advantage provided that only **unrelated infants** are killed and that the males increase their chances of siring the next infants.

2. Social pathology hypothesis,

infanticide as a result of crowded living conditions and not providing any advantage, regardless of **relatedness**.

How to test these two hypotheses?

Infanticide in lions/ monkeys



killed by males



Support the “sexual selection” hypothesis

Why do male lions have infanticide?

1. When a new coming, alpha male take over the female group (pride).
2. A strategy to force females sexually receptive; females give birth every 1-2 years.
3. Dominant α -males have short time-window to control the pride → have their own offspring asap.

A cost to females, benefit to males

Parent-offspring conflicts

Infanticide in humans, why?



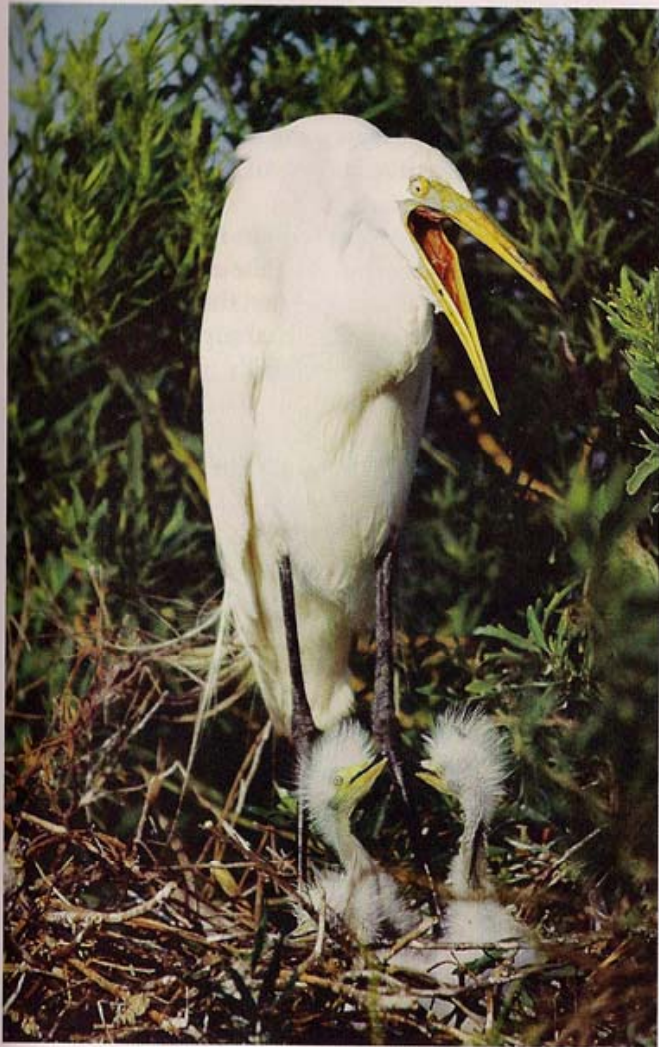
Sibling rivalry

each sibling wants to maximize its benefit



Sibling rivalry

Siblicide



Sibling rivalry

Siblicide



Siblicide in Booby

Older one kills
the younger one

Older one has
higher level of
testosterone

Sibling rivalry

Bigger sibling
repels the smaller one
Parents have no
interruption



Neighbor adults kill it.



Black eagle siblicide



Sibling rivalry

Siblicide



In Spotted hyena,
First one kills the second pup

Older one has higher
testosterone level than
the younger one

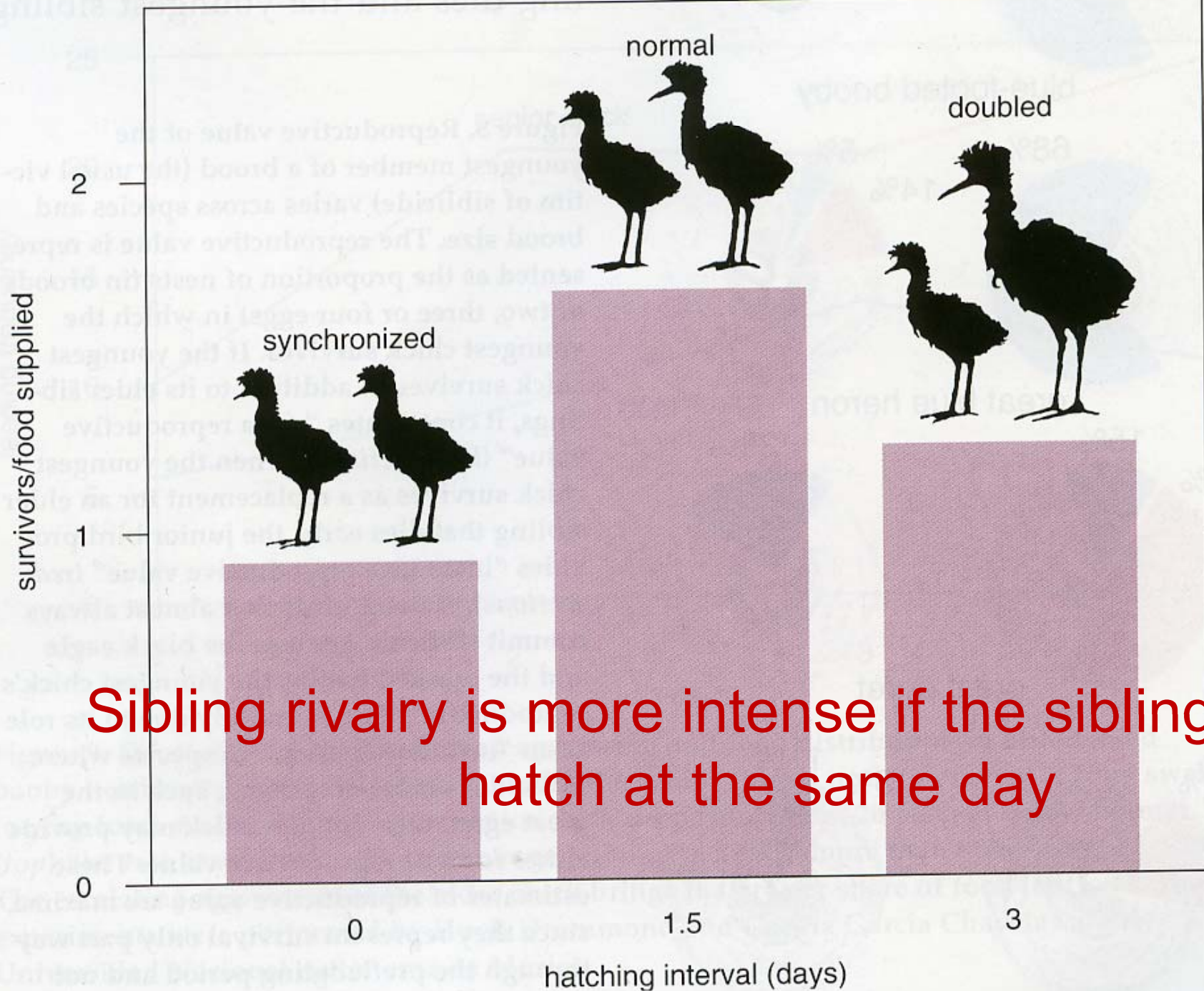
Why sibling rivalry? (Siblicide)

Limited food provided from parents

- Compete for food
- Compete for parent's feeding



Figure 5. Five characteristics are common to virtually all siblicidal birds (*from top left to bottom right*): competition for food, provision of food to the nestlings in small units, weaponry, competitive disparities between siblings and spatial confinement. Four of the traits are considered essential preconditions for the evolution of sibling aggression, whereas competitive disparities between siblings may be a consequence rather than a cause of siblicidal behavior.



Sibling rivalry is more intense if the siblings hatch at the same day

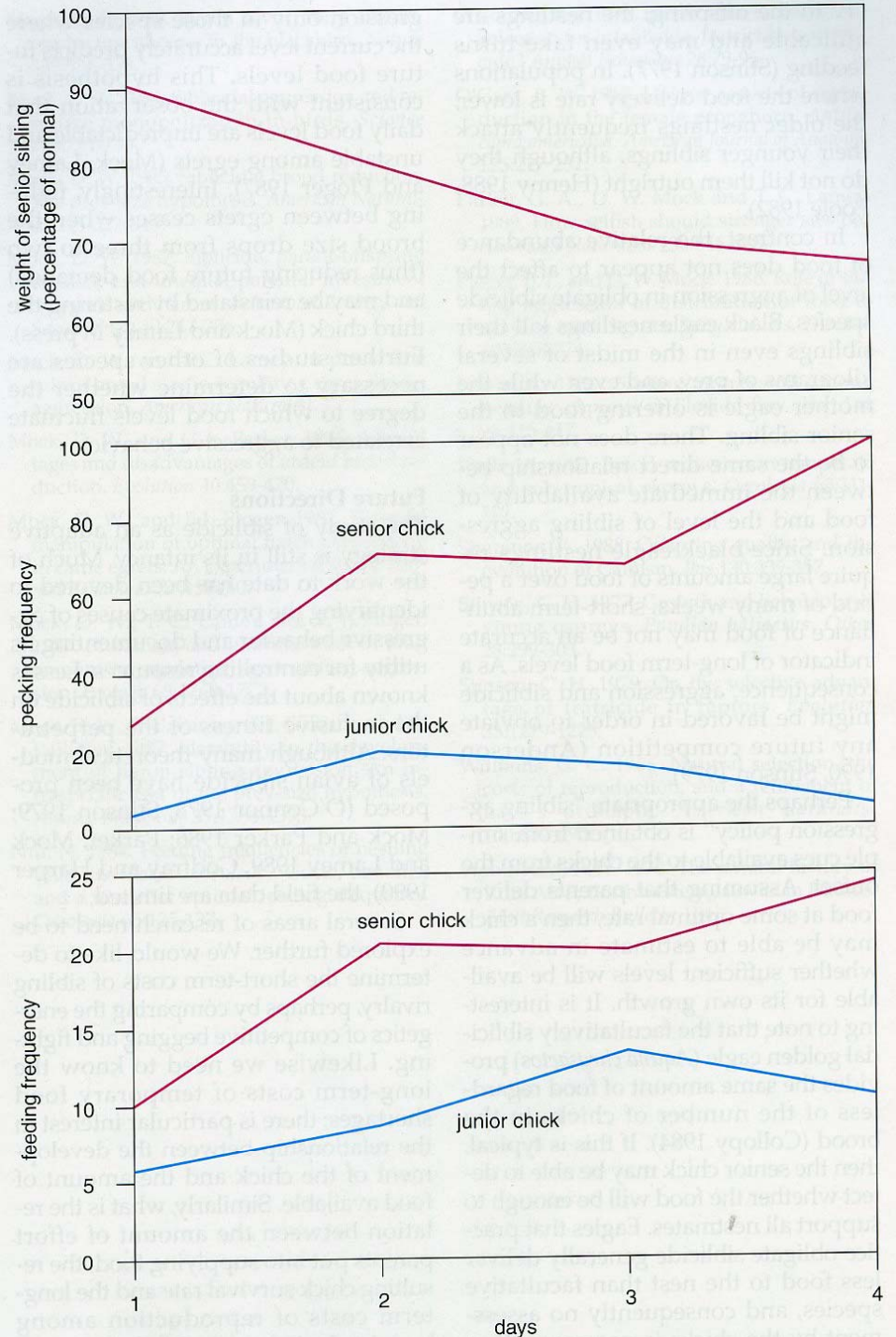
Food limitation is an important contribution of sibling rivalry?

Experiments to deprive food intake from older sibling...

Hungry older sibling

-- attack junior ones

-- increase testosterone levels



Sibling rivalry in humans



King Lear --Shakespeare

What exactly do parents provide?

Food,

Home,

Protection (from predator)

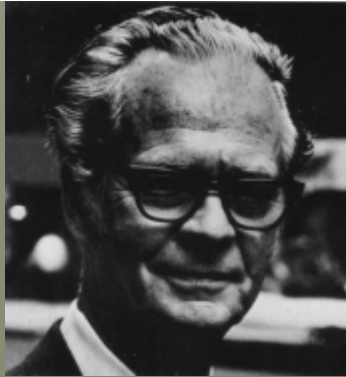
Skills to survive (tool-making, foraging)

Love??

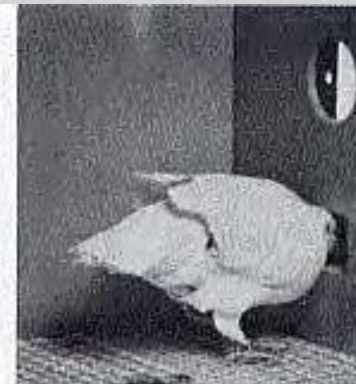
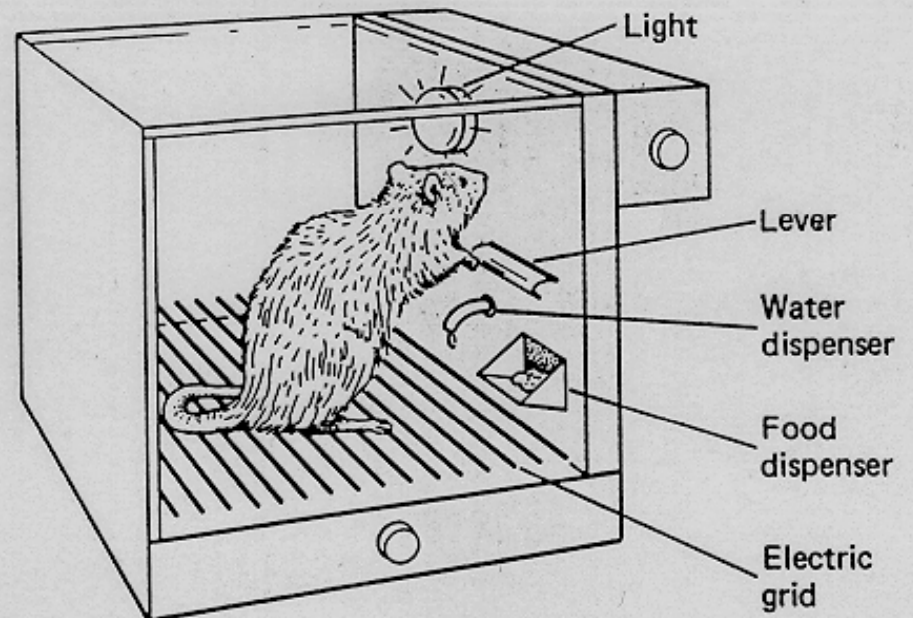
In operant conditioning:

Behaviors can be trained (learned) by providing reward or punishment, same as parenting (teaching) offspring?





Skinner Box



Skinner Box for humans?



Can operant conditioning apply to parental care?
Is it sufficient: parents provide reward/punishment
Is **love** or **attachment** really important?

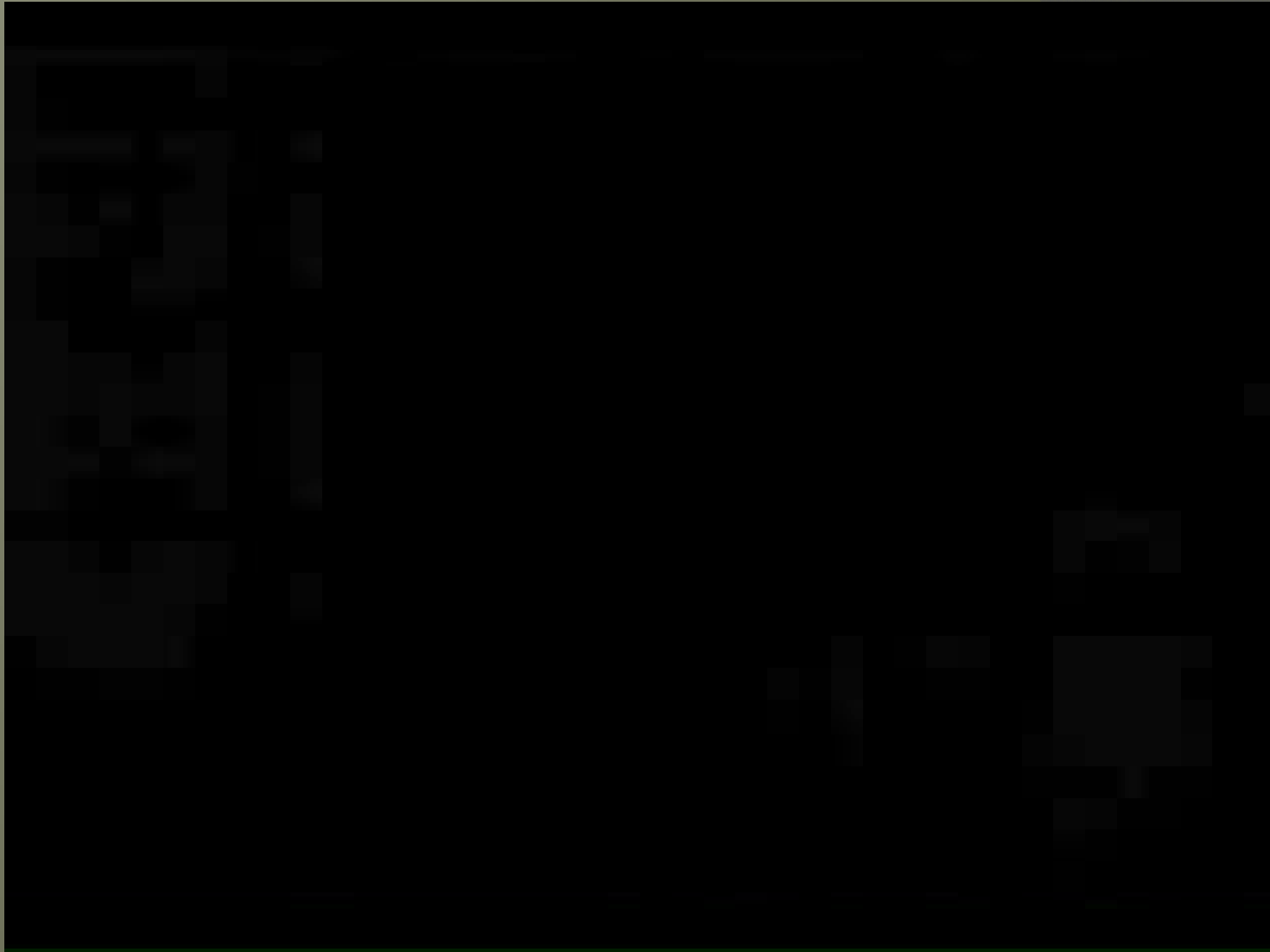
Harry Harlow
~1950s

Test the idea of
Infant-mother attachment

~ according to Skinner's
hypothesis, infants clung
to mom because of food
reward (conditioned).



Harry Harlow's experiment I:



www.youtube.com/watch?v=KlfOecrr6kl

Harry Harlow
~1950s

Test the idea of
Infant-mother attachment

~ ~~according to Skinner's~~
~~hypothesis, infants clung~~
~~to mom because of food~~
~~reward (conditioned).~~

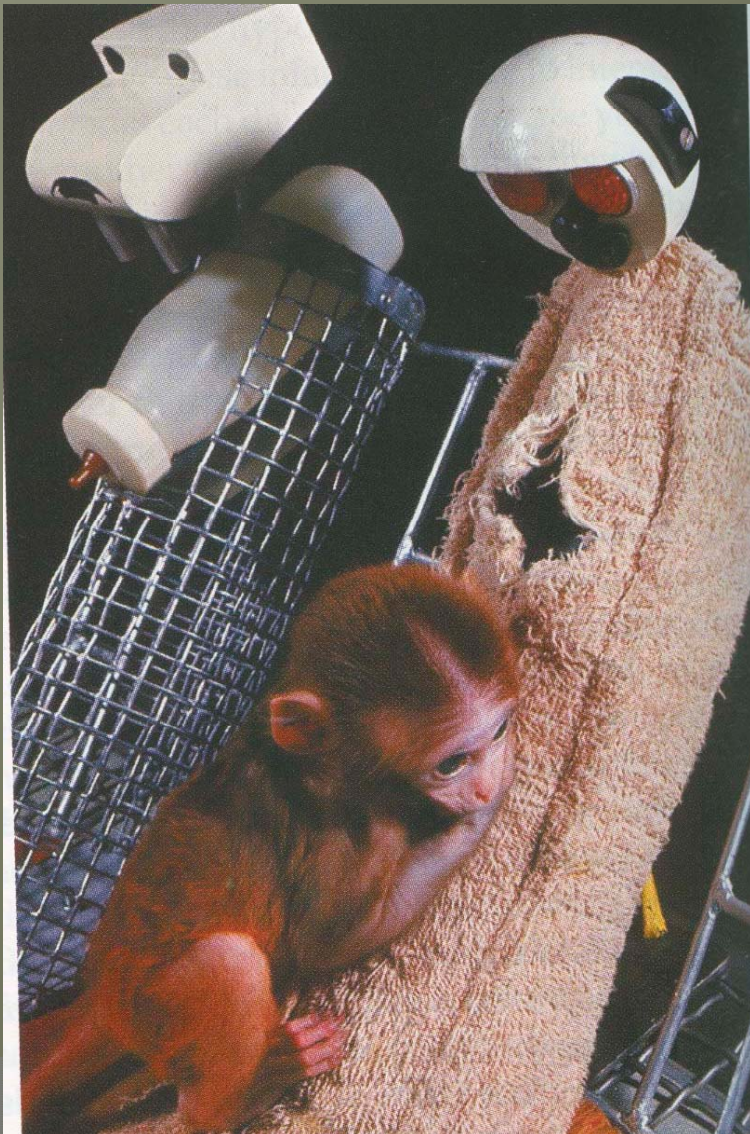


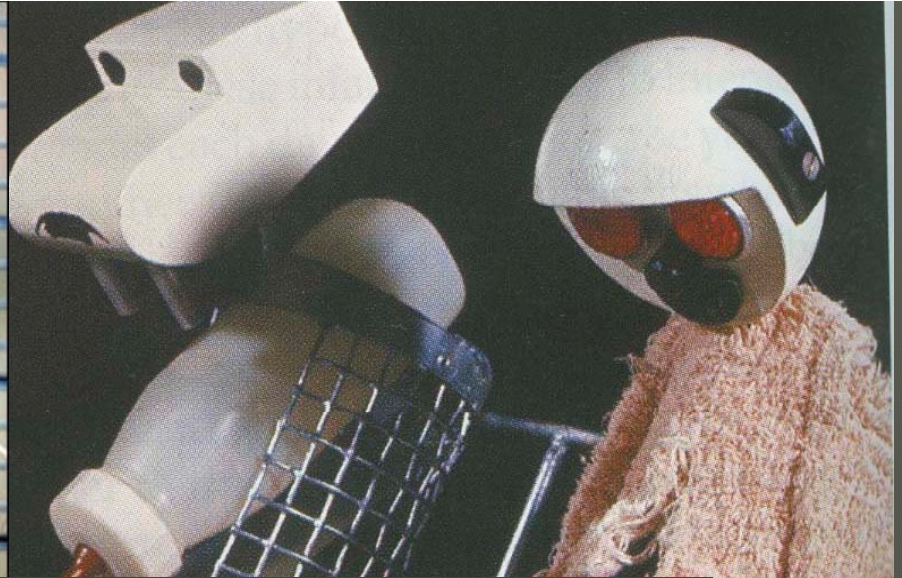
Harry Harlow's experiment II: fear response

Mom (parent) is the source of security and self-esteem

<http://www.youtube.com/watch?v=fg9QCeA4FJs&feature=related>

What is missing here?
(what else parents can provide)





Can these monkeys behave well when they grew up?
(reared by cloth mom)



As these “motherless” monkeys grew up: they suffered from depression
stressed
socially awkward



What did they miss from the mom?

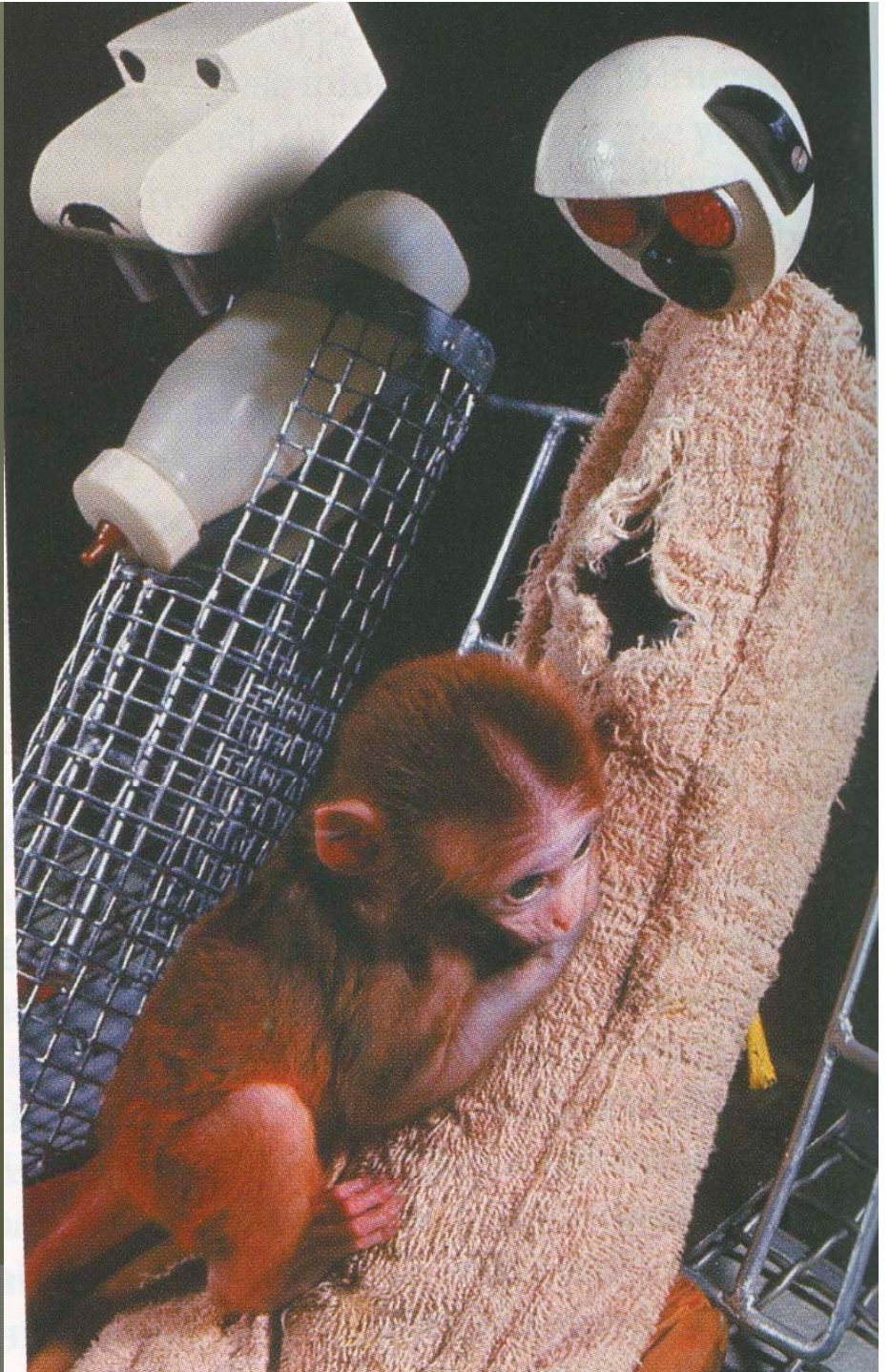
What happened when these
monkeys became mothers?
(motherless mothers)

- neglectful
- abusive
- stressed (depressed)

toward their own infants
over generations

Neglect begets neglect.

Abuse begets abuse

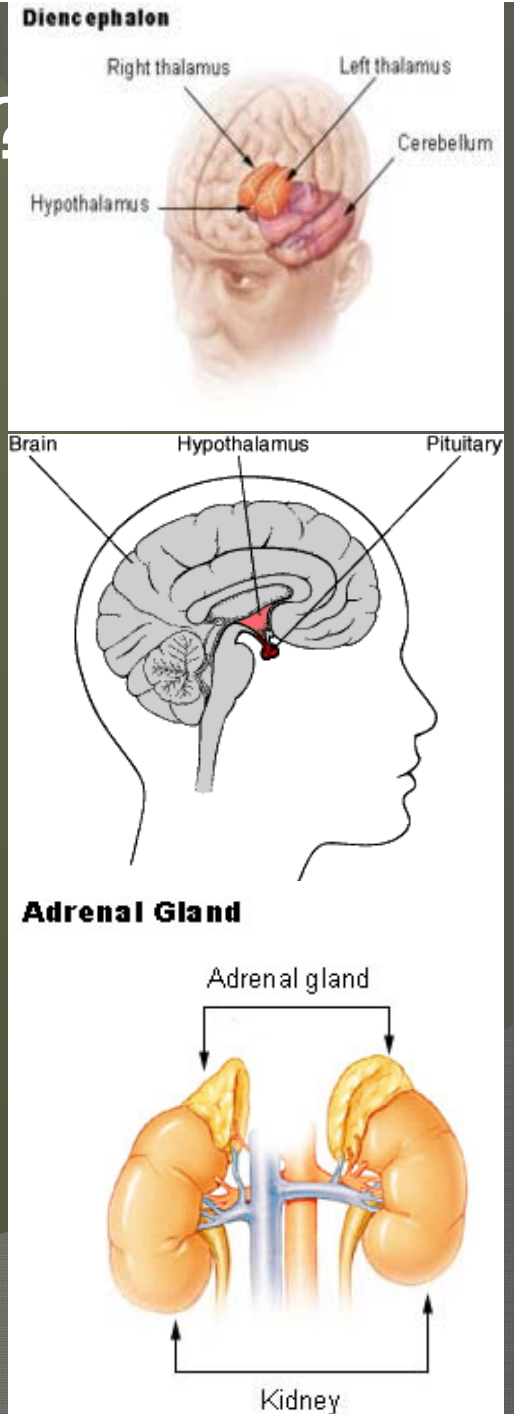


How do our body handle the stress?

Stress response (fight or flight):

Hypothalamic-pituitary-adrenal

is a complex set of direct influences and feedback interactions among the hypothalamus, the pituitary gland (a pea-shaped structure located below the hypothalamus), and the adrenal glands (small, conical organs on top of the kidneys). The interactions among these organs constitute the HPA axis, a major part of the neuroendocrine system that controls reactions to stress and regulates many body processes.



How do our body handle the stress?

Stress response



Blood pressure up

Digestive system inhibited

Muscle constraction

Shaking

Tunnel vision

Weaken immune system

Long term exposure under stressed environment:
→ hyper-sensitive to stress: affect mental/ physical health

When a mother-to-be is stressed (or abused), she produces more cotisol (stress hormone) than she otherwise would. Some of this cortisol is transmitted to the fetus through the placenta. –the elevated cortisol levels experienced by the fetus induces permanent changes in the response to stress: they makes it more sensitive and hyper-responsive to stressful events. Predispose to stress-related problems: anxiety disorder, depression, substance abuse, schizophrenia, PTSD.

Abuse begets abuse



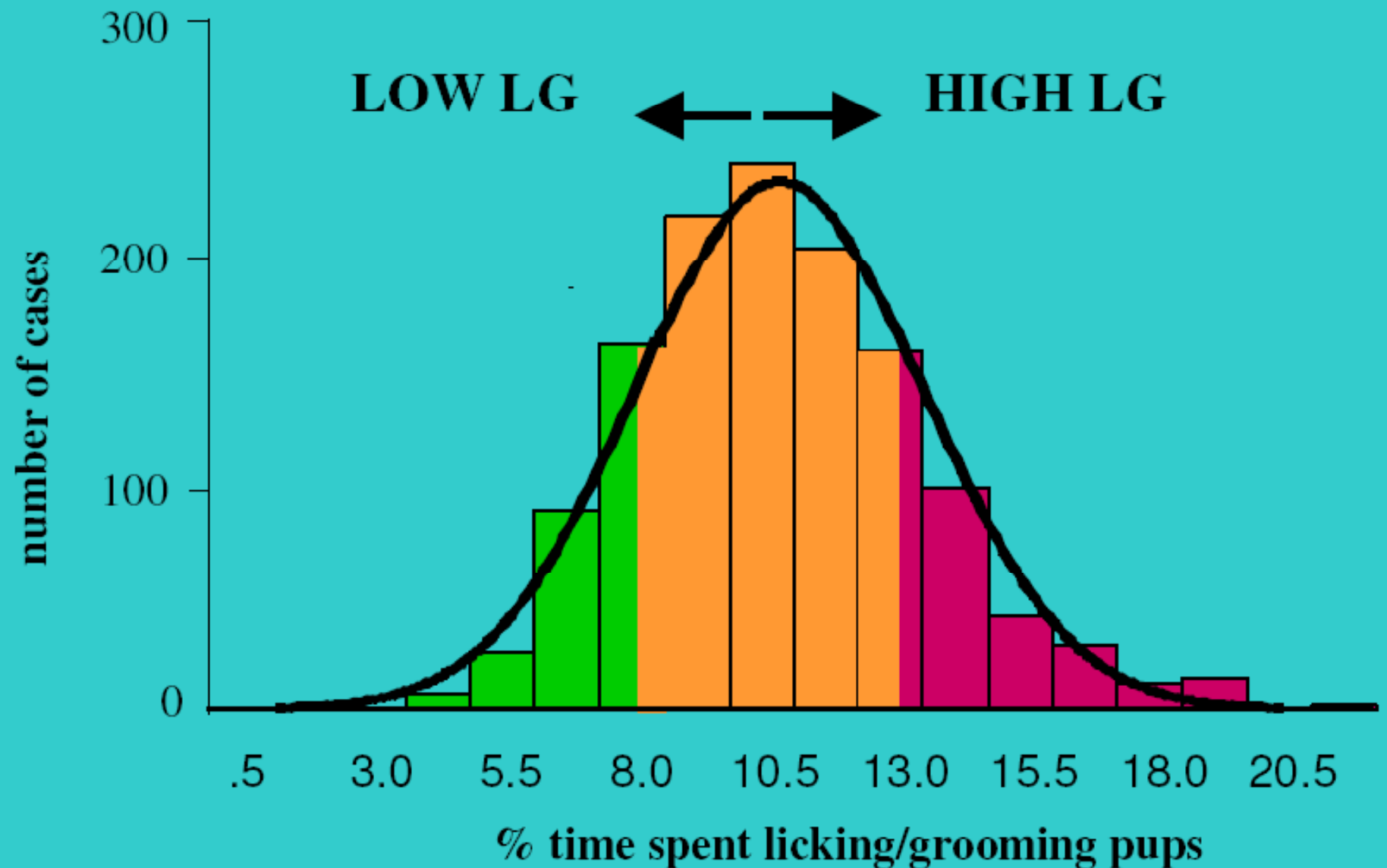
How can parent's love help offspring?

Parental care in Rats:

Mom: licking and grooming the pups



Frequency Distribution of Maternal Licking & Grooming of Dams (cummulative)



Licking and
grooming from
mom



produce
more **GC receptor**,
better
stress response



offspring
less depressed;
become mom-
licking/grooming

Natural Variations in
Maternal Care



Individual Differences in
Stress Response



Risk of
Psychopathology
(depression, anxiety)

Norway rats,

Offspring of high LG mothers

- less fearful, better stress response
- when grow up, high LG to their pups

Offspring of low LG mothers

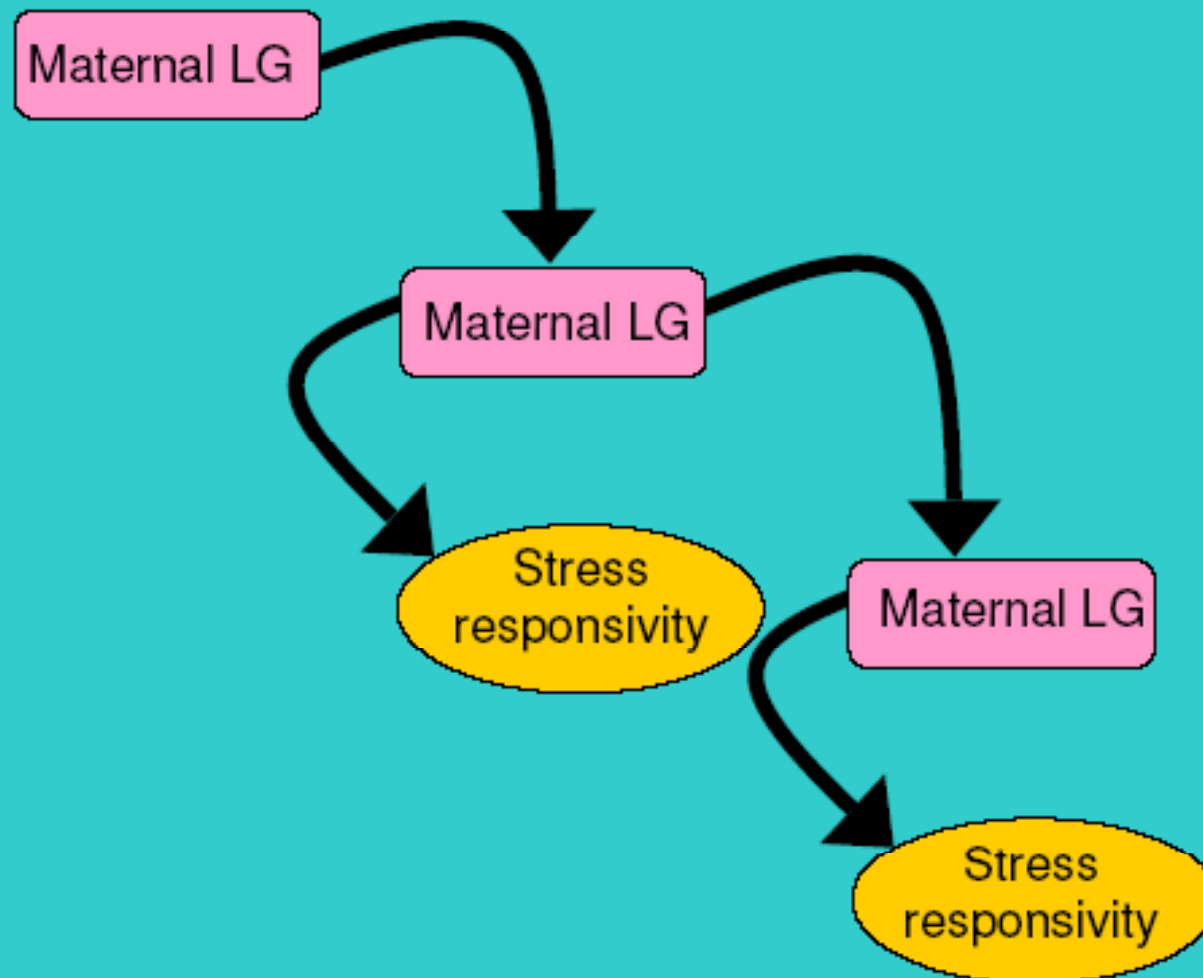
- more fearful, worse stress response
- when grow up, low LG to their pups

Fearful mom → fearful offspring

High licking/grooming (LG) mom and their offspring have more GR (Glucocorticoid receptor) and more SR (Serotonin receptor) in their brain.

- More GR and SR, better stress response.
- **High** LG mom/infants have **more** GR/ SR in the brain less fear to novelty; better stress response.
- **Low** LG mom/ infants have **less** GR/ SR in the brain.

Transmission of maternal care and stress responsivity across generations



Champagne & Curley, *Current Opinion in Neurobiology*, 2005

The mechanisms...

How does mom's licking and grooming induce different stress response, and pass on the offspring?

How does an event (maternal behavior) occurring so early in life have a long-term impact on behavior?

Epigenetic modifications to DNA

1. What is epigenetic?

2. Example(s) of epigenetic influence to the offspring from the father (in this article).

What is epigenetics?

Heritable changes in gene expression caused by mechanisms other than changes in the underlying DNA sequence.

Examples of such changes might be **DNA methylation** or histone modification, both of which serve to **suppress or activate gene expression** without altering the sequence of the silenced genes.

DNA contains 2 sources of information:

1) The DNA sequence

(CATTGGATTCCGGA)

GENOME



Generates
proteins

2) The structure of DNA

EPIGENOME



Serves as an
“on/off”
switch for gene
expression

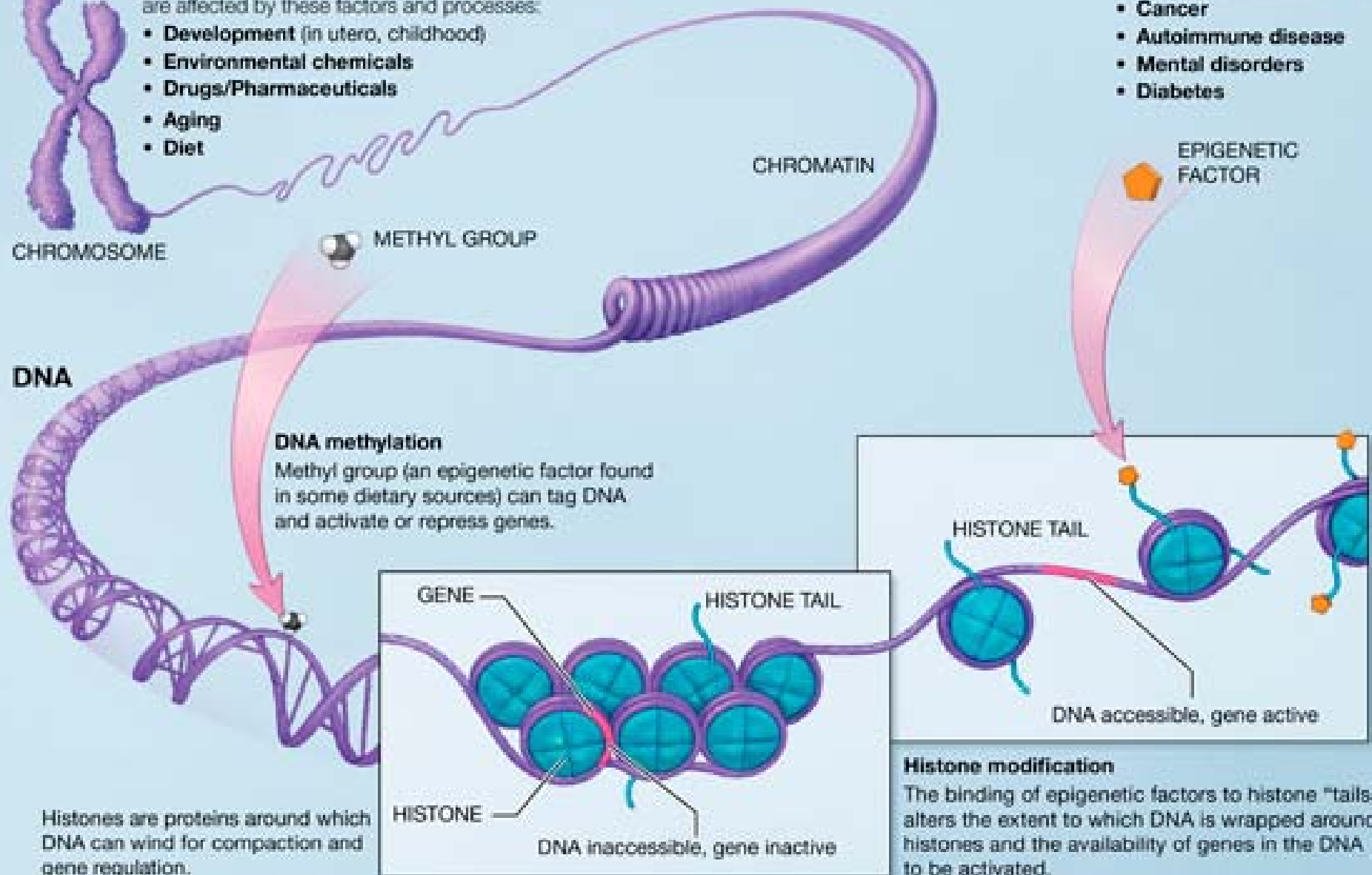
EPIGENETIC MECHANISMS

are affected by these factors and processes:

- Development (in utero, childhood)
- Environmental chemicals
- Drugs/Pharmaceuticals
- Aging
- Diet

HEALTH ENDPOINTS

- Cancer
- Autoimmune disease
- Mental disorders
- Diabetes



Epigenetic modification of DNA

GR Methylation in Response to Rearing Environment

Offspring reared by Low
LG Dam

ccccctctgctagtgtgacacactt **M**
Maactc **M**cagttggcggg**cgcgg**
accacccctgcgggctctgc **M**gctgg
ctgtcacct **M**ggggctctggctgc
Macccacggg**cggg**ctc**cga**gc**gcg**
gtccaagcc **M**gagtggg **M**ggg
gcg ggaggg agcctggg agaa

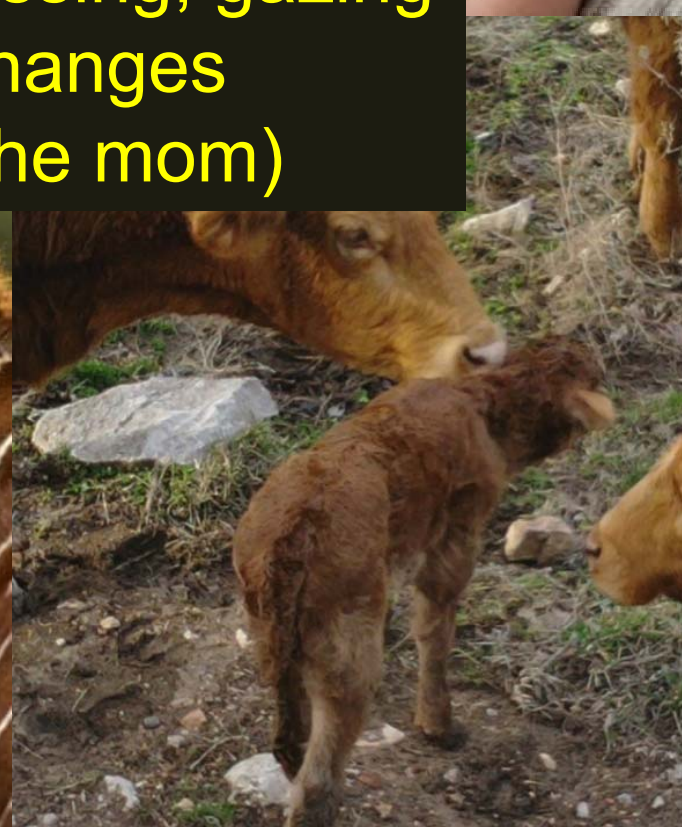
Offspring reared by High
LG Dam

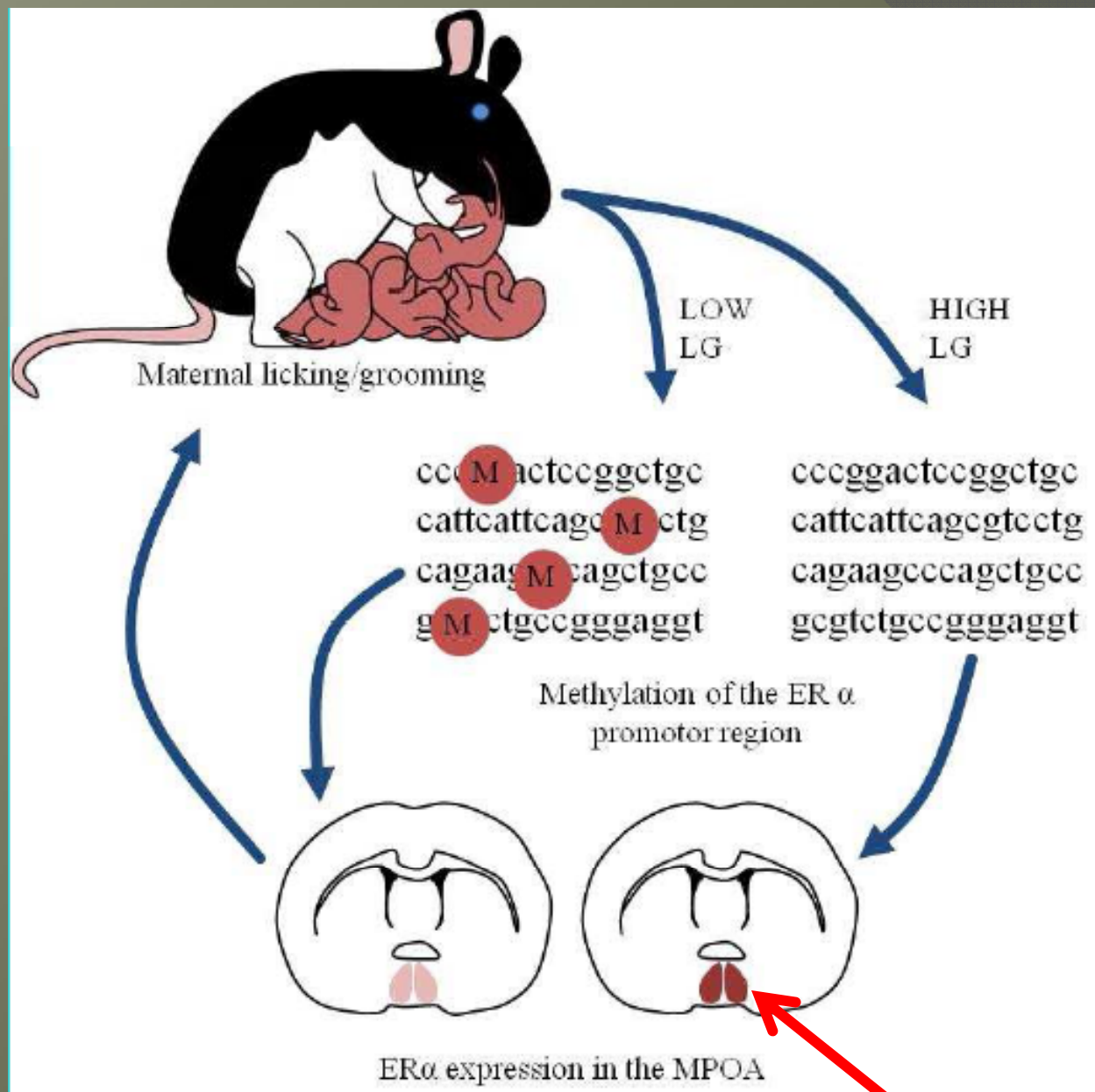
ccccctctgctagtgtgacacactt**cgc**
gcaactc**cgc**cagttgg**cggg****cgcgg**
accacccctgc**cgg**ctctgc **M**gctgg
ctgtcaccc **M**ggggctctggctgc
cgaccca**cggg****cggg**ctc**cga**gc**gcg**
gtccaagcc**cgg**agtggg**cggg**
gcg ggaggg agcctggg agaa

Same DNA sequence, but different extent of methylation
→ different expression of GR → different fear responses



Licking, hugging, kissing, gazing
induce epigenetic changes
of your child (also the mom)





More estrogen receptor express



Maternal Licking/grooming

LOW LG

HIGH LG

Increased GR
methylation

Decreased GR
methylation

Decreased GR
expression

Increased GR
expression

Increased stress
response

Decreased
stress response

GR= glucocorticoid receptor
(binds to stress hormone)



Nazca booby

First field study shows wild animals (booby) have the same conclusion:
abusive mom has abusive offspring.....



Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse

Abstract

Maternal care influences hypothalamic-pituitary-adrenal (HPA) function in the rat through epigenetic programming of glucocorticoid receptor expression. In humans, childhood abuse alters HPA stress responses and increases the risk of suicide. We examined epigenetic differences in a neuron-specific glucocorticoid receptor (*NR3C1*) promoter between postmortem hippocampus obtained from suicide victims with a history of childhood abuse and those from either suicide victims with no childhood abuse or controls. We found decreased levels of glucocorticoid receptor mRNA, as well as mRNA transcripts bearing the glucocorticoid receptor 1F splice variant and increased cytosine methylation of an *NR3C1* promoter. Patch-methylated *NR3C1* promoter constructs that mimicked the methylation state in samples from abused suicide victims showed decreased NGFI-A transcription factor binding and NGFI-A-inducible gene transcription. These findings translate previous results from rat to humans and suggest a common effect of parental care on the epigenetic regulation of hippocampal glucocorticoid receptor expression.